

"Risk as a Resource"

"Meeting the Program Management Challenge" Goddard Space Flight Center March 30, 2004

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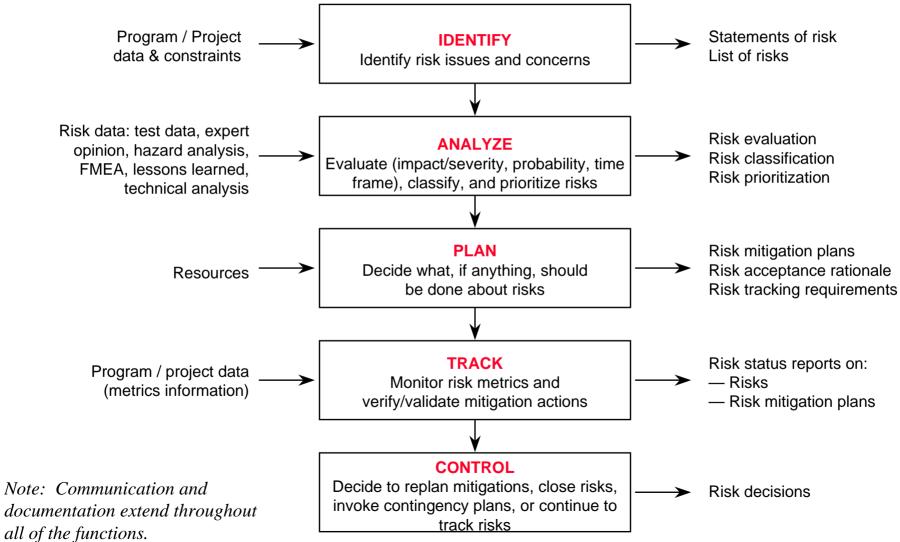
Topics



- → How Much Risk Mitigation is Necessary?
- → Risk Strategies Differences
 - → Unknown Risk
 - → Managed Risk
 - → Risk Avoidance
- → Risk Iceberg
- → "Risk as a Resource"
- → Product Assurance Role
- → Summary

Risk Management Process





Risk Strategies

Unknown Risk

Generally unacceptable for Government-funded projects due to fiduciary responsibilities associated with the use of public funds.

(Not acceptable for safety risks.)

May be appropriate when the consequence of the risk is acceptable.

Managed Risk

"Risk as a Resource"

Risk to mission success is optimized with consideration of numerous variables including criticality of the mission to the agency strategic plan, cost, schedule criticality, mission duration, performance, etc.

Higher Risk	Medium Risk	Lower Risk
Lower confidence in	Moderate confidence in mission success	Higher confidence in
mission success		mission success

Baseline set of SMA activities necessary to identify, understand, and characterize risks.

(SMA life-cycle activities.)

Class C

Class D

Safety Of People

"Risk Avoidance"

Minimized Risk

Risk to people is generally reduced to the lowest level reasonably achievable.

(ALARA)

Must be reduced to level below *De Manifestis risk* and is desirable to reduce to *De Minimus* threshold.

Unknown Risk



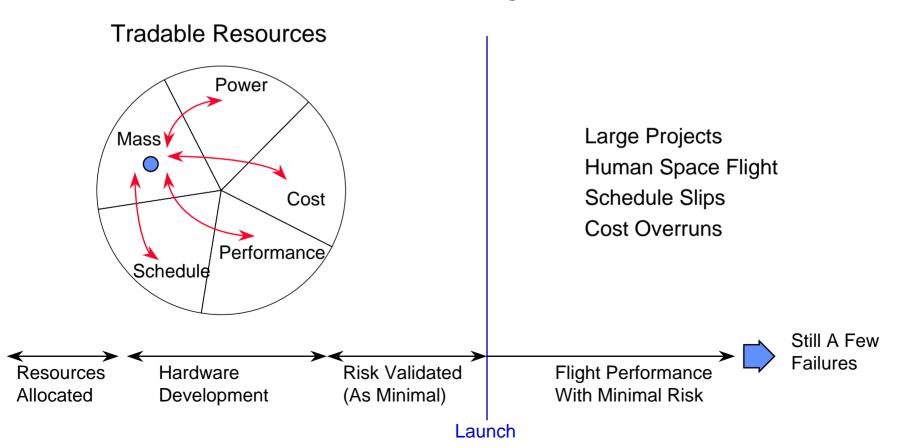
Unknown Risk Approach May Be Acceptable

- → Not acceptable for people safety risk
- → Very low cost projects (inexpensive sounding rockets and balloon payloads
- → Initial phases of technology development and demonstration
- → Missions where risk can be efficiently mitigated later through recovery and reflight like instruments on SOFIA or some balloon projects

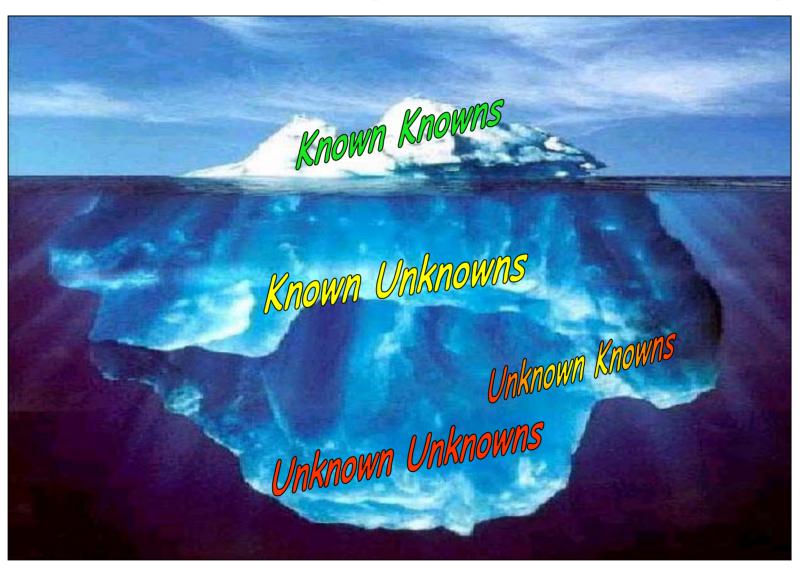
Risk Avoidance (Safety of People)



- → Risk to Be Minimized (Avoided). Rule-based Approach
- → Extensive Test and Analysis. Non-Compliance Formal Process
- → Quantified Risks When Possible
- → Residual Risk Is A Consequence of Deficiency in Tradable Resources or Lack of Knowledge



Lack of Knowledge - The Risk Iceberg



NASA

The Four Levels of the Risk Iceberg

- → Known Knowns
 - → Flight Data
 - → Test as you fly
 - → Demonstrated performance
 - → Flight or test-validated analysis, simulations and models, Operation within certification limits
- → Mitigation: sound program, engineering and operational management
- → Known Unknowns
 - → Generic but undemonstrated failure modes and hazards,
 - → Risk analysis uncertainties
 - → Acknowledged test and analysis limitations
 - → Unverified modeling and simulation based predictions
 - → Envelope expansion and operations within certification but out of family
- → Mitigation: conservative flight rules, technical standards and safety factors



The Four Levels of the Risk Iceberg

- → Unknown Knowns
 - → Mis-communicated test or analysis results
 - → Uneven understanding of data or environment
 - → Poor documentation combined with loss of corporate memory
- → Mitigation: clear organizational structure, good communications, trending
- → Unknown Unknowns
 - → Bad assumptions
 - → Untested new environments
 - → Unfinished experimental research
 - → Inadvertent operation outside of certification limits (temperature, Q, tire speed, etc.)
- → Mitigation: research and testing, rarely done by operational programs

Risk Avoidance Approach ISS Program Risk Management

Risk Identification

What could keep your team from achieving your objectives?

What objective is at risk?

Methods:

- -Expert interview
- -Trend Analysis of metrics
- -Systematic analysis of WBS levels
- -Comparison of goals and plans

Key areas to assess:

- -Requirements
- -Technology
- -Management
- -Engineering
- -Manufacturing
- -Supportability (Logistics & Maint.)
- -Operations
- -Safety
- -Programmatic or Political

Information Sources:

- -Metrics
- -Historical data
- -Resources
- -Suppliers
- -Plans
- -Proposed Changes
- -Test results

Risk Analysis

Determine the root cause

Quantify Your Risks:

Determine likelihood of event Determine team's consequences

- -Technical (Performance,
- Operations, Safety, Programmatic)
- -Cost
- -Schedule

Plot risk on ISS Risk Matrix Enter risk & analysis data into Risk Data Management System (RDMS)

Questions to Consider

- -Do risk statements fit within your Team's Team Execution Plan (TEP) description of responsibility, authority, accountability?
- -If not, recommend risk for elevation.
- -Have you considered all sources for identifying risks?
- -Do other teams need to know these risks?
- -Are the mitigation plans adequate?
- -Do they address the sources of risk?
- -Has the next level of management reviewed these risks?

Risk

Monitor and Control

What can you do about a risk?

Abatement

Conduct trade study

-Identify best solution

Develop mitigation plans

- -Reduce likelihood of occurrence
- -Reduce severity of consequences
- -Redesign
- -Develop prototypes
- -Modify requirements
- -Acquire resources
- -Augment test or analysis
- -Re-negotiate

Develop contingency plans

Accept the risk

Recommend elevating risk to higher team

Enter abatement plans into RDMS

Risk Communication

Status risks monthly

- -Update data in RDMS
- -Update matrix

Implement abatement plans

Review and Elevation of Risks:

- -Review lower teams' risks
- -Agree or disagree with assessments
- -Elevate risks to your team as appropriate
- -Identify and assess additional risks for your team
- -Combine risks as appropriate
- -Plot your team's risks on the ISS Risk Matrix
- -Recommend risks for elevation to higher team

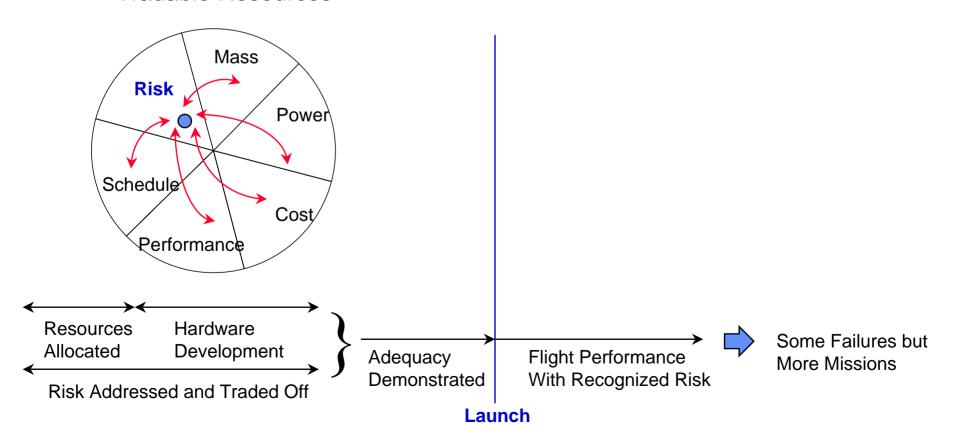
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Managed Risk - "Risk as a Resource"

→ Risk to Be Identified and Thoughtfully Traded as a Resource with an Appropriate Level of Mitigation

Tradable Resources

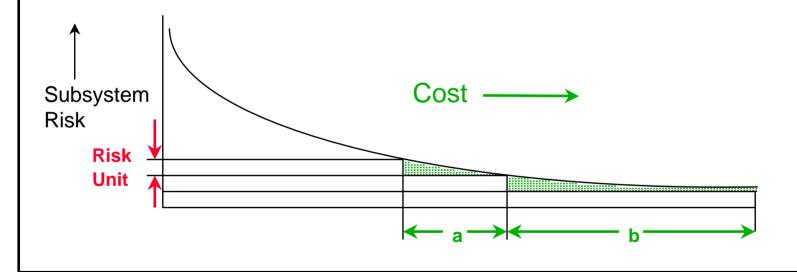




Reducing the Cost of Risk

Marginal Cost of Risk

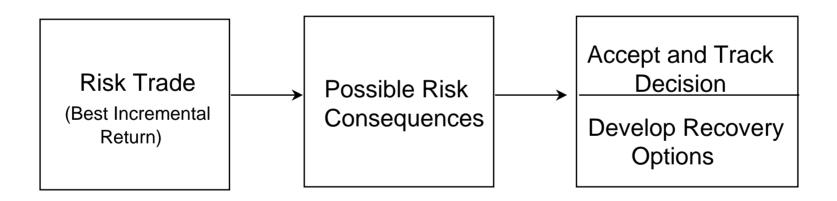
→ When the Cost Per "Unit of Risk Reduction" in a Given Component or Subsystem Increases Significantly -- STOP. Buy Down Risk Somewhere Else.





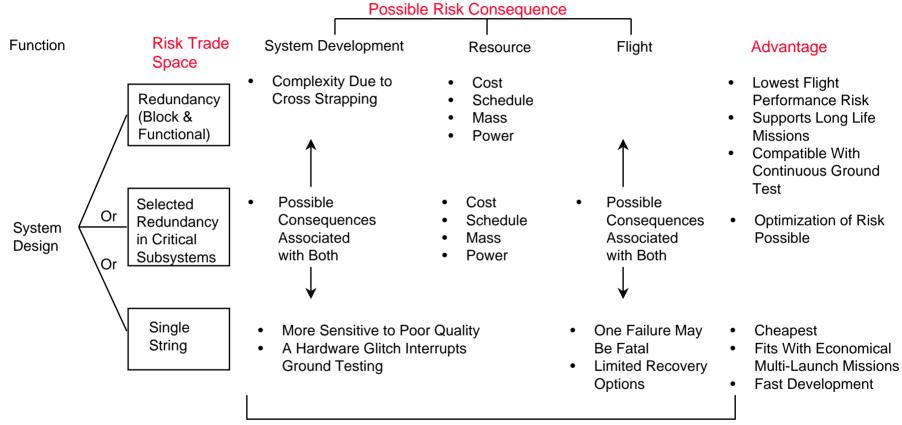
Risk as a Resource Process

The Goal is to Optimize Overall Risk Posture through Accepting Risk in One Area to Benefit Another. A Strategy to Recover From the Occurrence of the Adverse Consequences Must Also Be Considered.



Risk as a Resource - Redundancy or Single String

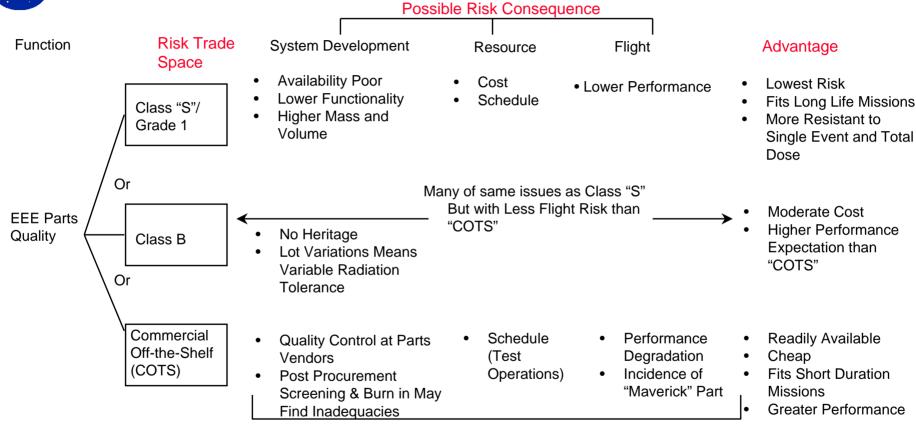




- Reliability Trade Analysis
- Redundancy Switching Analysis
- Failure Mode Analysis Analysis of SPF
- Hardware Flight Performance Histories
- Criticality Analysis

Risk as a Resource - Class of EEE Parts

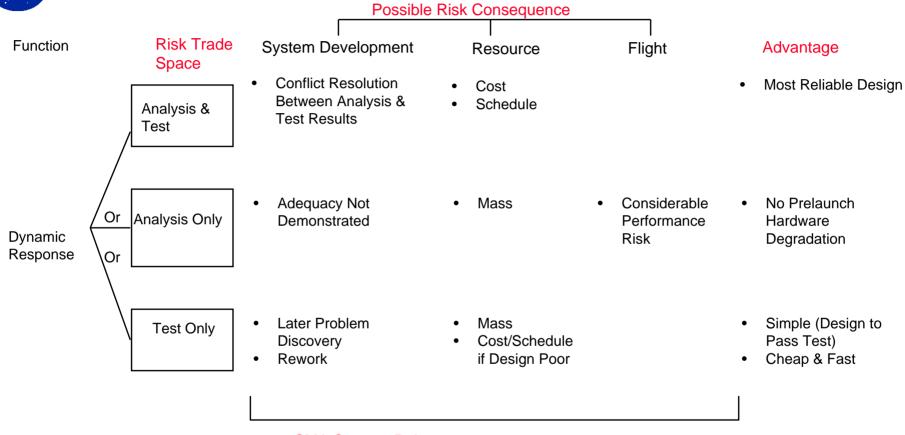




- Procurement Specifications
- Vendor Qualification / Assessment
- Upgrading Process Definition
- · Parts Testing Program
- Residual Parts Risk Assessment



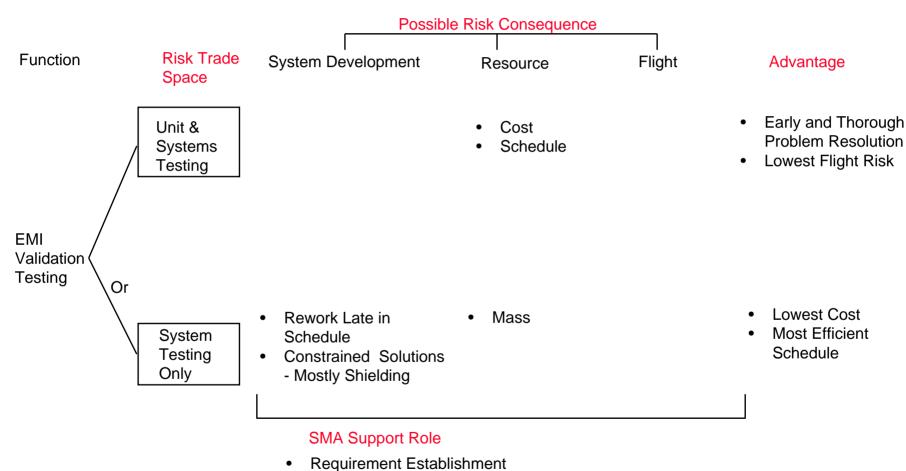
Risk as a Resource - Design Validation



- Test Requirement Definition
- Analysis Verification
- Test Oversight
- · Residual Risk Assessment

Risk as a Resource - Component Level Validation (e.g., EMI)





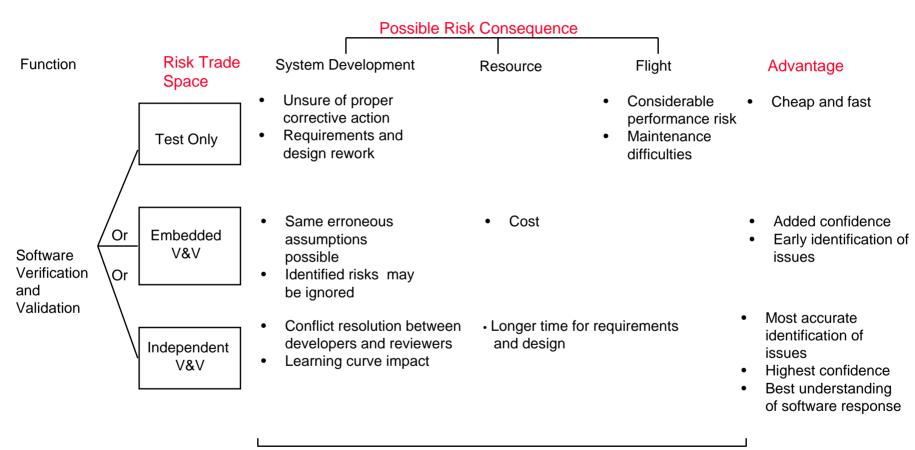
Mitigation Strategy Development

Definition of Residual Risk

Problem/Corrective Action Assessment

Risk as a Resource - Software Verification & Validation





- Test Requirement Definition
- Level and Scope
- Test Oversight of IV&V

Risk as a Resource -**Technology Utilization**



Possible Risk Consequence

Risk Trade **Function Space** Advanced Technology* Technology Or Utilization Existing

System Development

- Technology Readiness Uncertainty
- Greater (Imbedded) **Functional** Complexity
- Interface Uncertainty

Resource

- **Development Costs**
- Possible Redesigns Late in Lifecycle
- Backup Design Cost
- Technology Readiness Schedule
- Qualification Cost

Flight

- Unknown Failures .
- **Untried Recovery**

Advantage

- Quantum Performance to Resource Improvement
- Less Hardware and Less Integration Complexity

Technology**

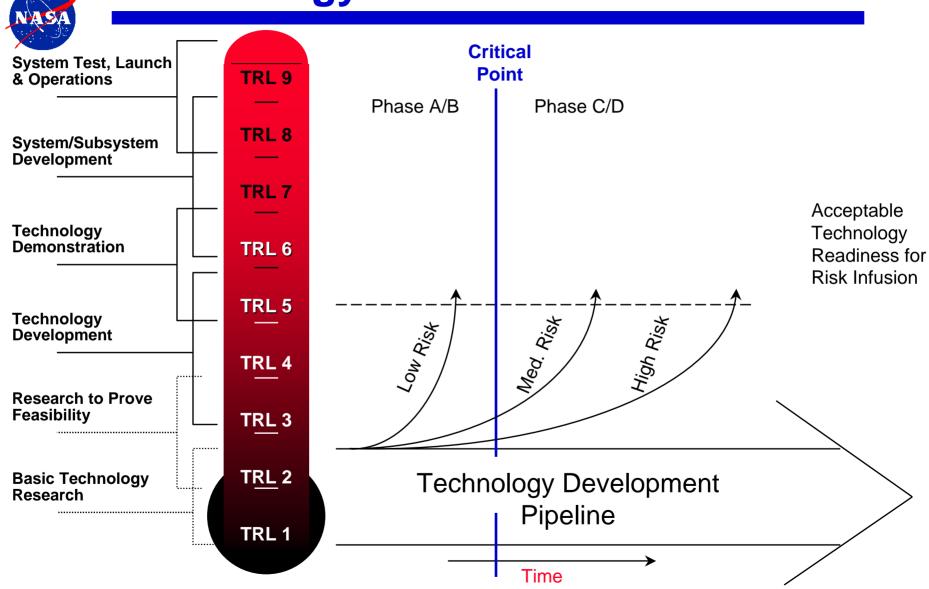
- Constraints on Other Subsystems
- Resource Compromise May Induce Failures
- Heritage Traps

- Mass
- Power

- Work Around Complexity
- Qualified and Flight Proven; Heritage
- Availability
- Confidence in **Established Reliability**

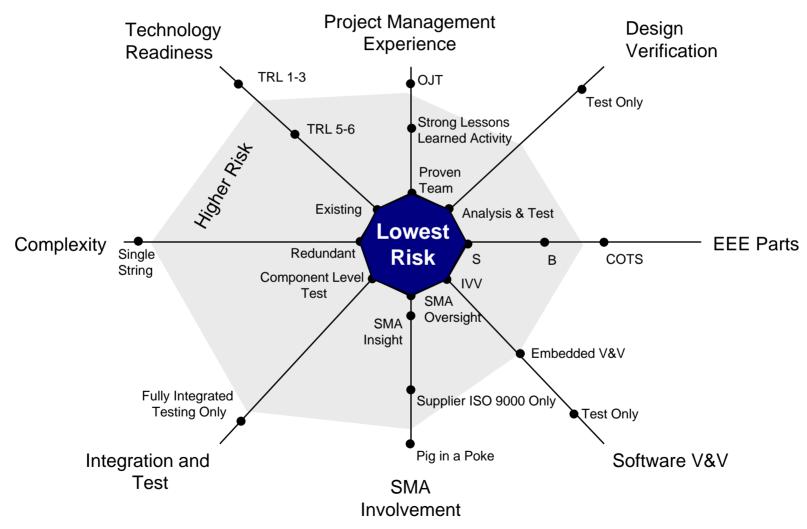
- **Technology Readiness Assessment**
- Reliability Estimates
- Co-participation in Qualification Plans
- Risk Assessments Support

Technology Infusion Risk





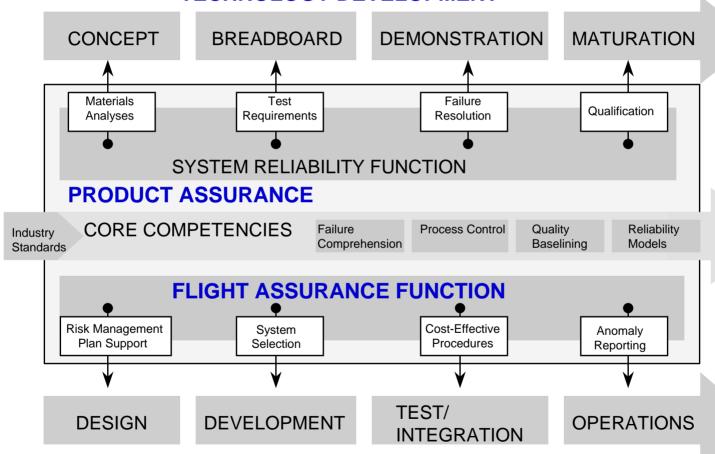
Risk Surface (Notional)





Product Assurance Role Across Life Cycle

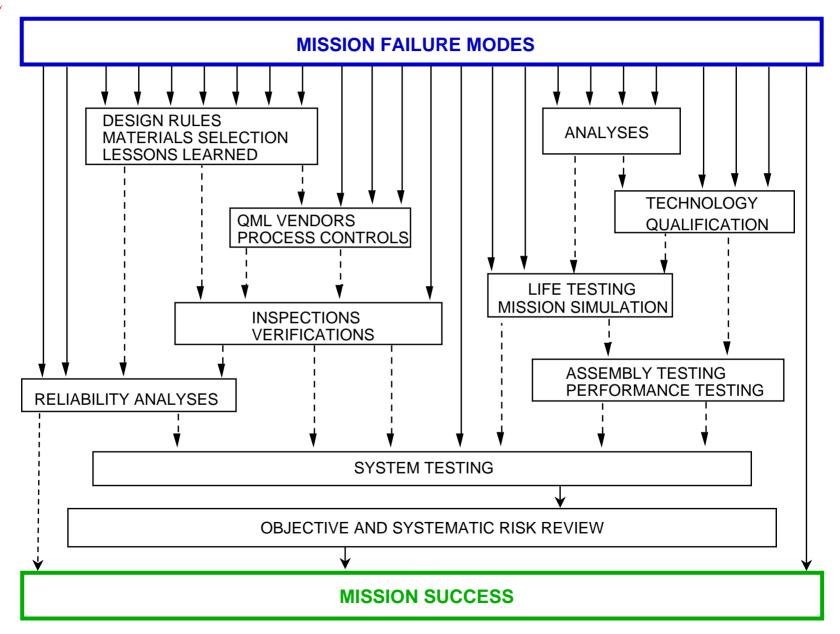
TECHNOLOGY DEVELOPMENT



SPACECRAFT DEVELOPMENT

RAND







CALVIN & HOBBES











Summary

- → A structured risk management approach is critical to a successful project
- → One size does not fit all; It is tailorable to risk acceptance willingness
- → Risk may also be managed as a resource to reach optimal posture
- → Elements of good project management are obvious but we still seem to make mistakes, failing to see the consequence of our decisions
- → S&MA community can provide valuable support as risk identification, analysis, and mitigation consultants